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AN APPROACH AND INSTRUMENTATION FOR MANAGEMENT SYSTEM ANALYSIS

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This report specifies an approach for accomplishing system analyses of complex management functions. A data collection instrument designed for mapping the communications network of the Navy manpower planning system is described. The instrument solicits from system participants the data necessary to trace both formal and informal information flows and make cost-benefit judgments about specific communications. The format developed for organization of the collected data is especially suitable for descriptive network analysis. Additionally, it provides a framework for comparison of producer and consumer views of the raw data and intermediate information products generated and utilized within the management system. Such comparisons are indispensable to diagnosis of possible system malfunctions and the prescription of changes.

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FOREWORD

The advanced development covered in this report is in support of a Manpower Requirements and Resource Control System (MARRCS), which is being developed as a subproject under Technical Development Plan P-43-07X, Manpower Management Effectiveness. The overall objective of MARRCS is to test and evaluate technologies directed toward improved manpower resources management. Phase I of MARRCS involves an analysis of existing Navy manpower planning and programming processes in order to establish a basis for improving current systems management and directing future systems development.

The work accomplished in this report was under the direction of Mr. Elmer S. Hutchins, Jr., Phase I Project Director. Overall guidance was provided by Dr. Richard C. Sorenson, Associate Director for Management Systems Research and Development.

The assistance of the MARRCS project staff in the collection of the data used in this study is greatly appreciated. Dr. Raymond E. Willis, University of Minnesota, was a valuable source of consultation in the initial development of Phase I.

J. J. CLARKIN
Commanding Officer

SUMMARY

PROBLEM

Efforts to improve the operating performance of any complex management system through structural changes necessarily depends upon the quality of established knowledge about the system. Of primary concern is the requirement for accurate description of information flow patterns within the organization under study, since the production of information (often in the form of decisions) is a major function of such systems. What is required, then, is a technique for gathering the data necessary to construct an accurate network description, isolating the most important attributes of system products (both intermediate and final) for examination.

OBJECTIVE

The objective of this effort was to develop an approach for data collection and organization to permit accurate definition of the communication network within a management structure and to provide a basis for preliminary cost-benefit evaluations. This objective was in response to Phase I of the Manpower Requirements and Resources Control System (MARRCS) project, which embraces a systems analysis of the Navy manpower planning system. In a more general sense, an attempt has been made to develop a methodology to assemble descriptive and evaluative information on system information products which could be applicable in the analysis of any management function.

BACKGROUND

The MARRCS Phase I systems analysis focuses on a description of the Navy management mechanism which assigns billets to functions (operating and support), and which determines manpower requirements under budgetary and personnel inventory constraints. In addition to serving as a basis for future advanced development of the manpower planning system, the Phase I results are intended to be of immediate use to managers in the system itself. In order to meet either of those goals, the methodology for data collection must be constructed so as to accommodate the high degree of diversity which exists among the various components of the total system. To obtain a preview of the degree of diversity which could be expected, the operational system administered by the manpower managers was examined and a conceptual model of the manpower allocation process was developed. This model suggested the kinds of information which would be encountered in the management system as well as attributes of that information.

APPROACH

A review of existing literature in the systems analysis area was made to discover an approach to data collection, organization, and analysis that was applicable to the requirements of Phase I MARRCS. No completely adequate approach was discovered. Thus, an effort was initiated to define the data requirements and to develop a data collection strategy.

The data collection was structured around the basic paradigm of a "communication," consisting of a producer (for whom the communication is an output), an information module, and one or more consumers (for whom the communication is an input). A questionnaire was designed to gather data from system participants, which focused on information inputs and outputs of each participant as well as the transformation processes employed between the two. Each respondent was to provide perceptual data, descriptive and evaluative, about each member of both sets of communications. Thus, a framework was created in which intra-system communications would be described twice, once by their consumers and once by producers. This framework provides an opportunity to compare differential perception and some basis for making performance evaluations of system components.

FINDINGS

In general, this approach to systems analysis appeared to yield data reflecting actual system operations. Review of preliminary results by a group of respondent-participants gained high grades for accuracy. The isomorphism of the questionnaire-defined network with the network as defined by formal documentation encouraged belief in the internal consistency of the data collection instrument, and high response rates to its questions argued further than the questions could be translated freely into the "language" of the managers.

RECOMMENDATIONS

The approach presented in this report is viewed as a good first step toward the development of a general-purpose tool for systems analysis of management systems. While further work will be required to refine its measurement accuracy, the possibilities for extension of this approach to other systems are clear.

CONTENTS

INTRODUCTION

PROBLEM

Efforts to improve the operating performance of any complex system through structural change depend on the foundation of knowledge assembled about the internal dynamics of that system. Accordingly, the Phase I effort in the Manpower Requirements and Resources Control System (MARRCS) project has been directed toward building a solid base of knowledge about the Navy manpower planning management system. Only on such a foundation are problem diagnosis and prescriptions for change possible.

Methodological issues need to be addressed prior to construction of this information base. System-bounding criteria must be established in order to focus the study in a manageable way. Cost-benefit measures must be developed to enable evaluations of effectiveness. The approach must be capable of revealing the actual mode of system operation, including both formal and informal processes. Additionally, the critical descriptive dimensions of system components must be well defined to allow the development of an effective data collection instrument. For more complex systems, this list of dimensions would be voluminous. Therefore, priorities must be set and a decision reached concerning the cost-benefit tradeoff involved in the collection of data on any single dimension or group of dimensions. Once this set of questions has been answered, attention must be turned to the techniques to be applied to the collection of the information viewed as important.

The information gathered through the application of the tools developed in this approach will be used to identify development opportunities and to establish priorities for such development. Additionally, it should permit evaluation of alternative manpower management systems with the objective of achieving increases in organizational effectiveness.

OBJECTIVE

For the purposes of Phase I MARRCS, the manpower management structure in the Navy is viewed as a large-scale, complex information-processing mechanism – an integrated set of decision producers and consumers. As such, an appropriate framework for proceeding with system description and evaluation is network analysis. Information-processing units (these may be either individual human participants or groups of persons) are conceptualized as network nodes. The connecting arcs represent the communications, denoted as processing unit inputs and outputs. Inputs are defined as all those information "packets" necessary to the functioning of the unit which are produced external to the unit. Outputs are defined as the information packets produced by the processing units and distributed to processors located either within or outside the system. The same output might be directed toward more than one node in the system. Any given node is likely to have more than one input, garnered from more than one source. It is also probable that more than one output will be identified, each of which may have more than one destination. In dialogue situations, two nodes will be connected with inputs and outputs, both flowing in both directions. If the average number of arcs connecting to a node is even moderately large (say, 8 or 10), and if the expected number of participants (in the range of 100) is accurate, the difficulties involved with system representation are readily apparent. The network analysis must be capable of reducing this complexity.

In order to characterize the total manpower process, information must be assembled to describe the processing procedures or algorithms employed by each participant. The communications which link the participants to one another must be specified from each of two perspectives, the consumer's and the producer's. This dual specification enables the cost-effectiveness analysis discussed below. Figure 1 represents the conceptual basis for the construction of the network. Each participant fills both consumer and producer roles. Their characterization of both inputs and outputs is necessary, as well as some description of the process employed, to transform the latter from the former.

This network analysis approach differs from the more traditional systems analysis in that it applies cost-effectiveness measures to evaluate the decision-making process itself rather than to evaluate decision alternatives within a process. (The more traditional framework will be employed when it becomes possible to investigate the actual processing patterns within critical nodes in the system.) In order to meet the current objective, performance measurements must be gathered both within the management system and at its boundaries, where it directly interacts with its principal "customer," the operational Navy. It is one of the objectives of this study to design and validate the standards which will be applied to this measurement problem.

The study will seek to identify the informal as well as the formal manpower decision network. In order to expose the current operating mechanism, it will be necessary to identify actions which are not necessarily based on formally designated decisions but which imply the transmission of information nonetheless. It is expected that, in many instances, informal telephone contact will prove as important to the functioning of the entire system as the communication of formal documents. Contrasts between formal and informal networks, if existent, will be made in hope of determining system development needs. Concomitantly, attention will be paid to the possible mislocation of planning and programming decisions in time and organization.

Attention will be directed toward the final goal of producing a useful description of the operational Navy manpower management system. Because the personnel occupying the

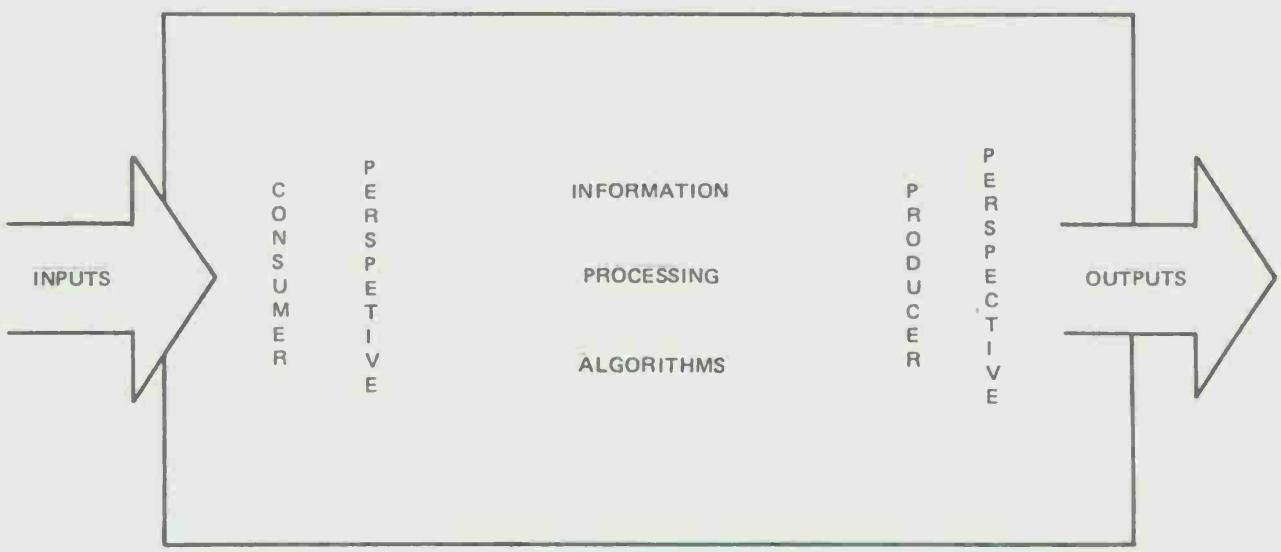

Figure 1. Conceptual basis for network analysis.

critical billets within the management system are always changing, the structure of the comminications network is in a continuous state of flux. Therefore, the system description will necessarily be a snapshot, dated and decreasing in utility as time passes. In order to maintain a clear image of the actual operation, data collection would have to take place at regular intervals in the future. The instrument developed for the initial description would be of higher value if it could be readily altered to become a management tool for the purpose of data base updating.

In addition, some standards must be established for the evaluation of system performance. This involves investigation of the "return" realized by the Navy per dollar expended on the manpower management staff operation. Of course, the challenge here is to determine just how this return can be measured in a meaningful way. Therefore, care must be taken to specify exactly what task this management system is expected to accomplish. Task definition serves to bound the scope of the effort, thereby facilitating elimination from consideration those organizational entities not actually in the mainstream of manpower planning.

BACKGROUND

In the Phase I study, we are intent upon describing the management mechanism which allocates billets to Navy functions (operating and support), and determines manpower requirements in the face of budgetary and personnel inventory constraints. A decision in the Navy's manpower planning network can be viewed from a number of perspectives, depending upon the scope of the investigation. It is this scope which determines how a particular piece of incoming information (an input) should be incorporated into the processing technique of an organizational component. In some instances, a particular packet of information might be treated as an assumption or as a "given" to be entered into the constraint set. In others, this same packet might be viewed as a decision variable, subject to the decision maker's control.

Although the focus of this study is the management system, the system cannot be adequately analyzed unless one has developed an understanding of the operational needs which it fulfills. This will determine the expected subject matter context for communications emanating from different points within the system. It cannot be assumed, however, that the existing management information system will reflect the significant knds of information and decision needs of the operational system. It is certainly possible that the flows of information expected may not exist at all; or that, if they do exist, they may not trace to the components in the system which might seem to be their most logical generators.

A CONCEPTUAL MODEL OF THE MANPOWER ALLOCATION PROBLEM

The approach of this study is to proceed from the structure of the operating system to the analysis and evaluation of the management system. A model has been constructed in an attempt to define the nature of the allocation problem which the management system as a whole is attempting to solve. A firm grasp of the attributes of this problem should contribute toward both the description of the system and the development of criteria for its evaluation.

A systematic analysis of the information relevant to the Navy manpower planning function could easily extend beyond CNO, SECDEF, and even the Congress. As the focal point becomes more specific, the breadth of the utilized information pool decreases. The following assumptions act to narrow the system concept of the study to a feasible scope:

1. The multiyear JCS objectives (JSOP II) are assumed to be givens (i.e., the set of strategic "tasks" to be completed by the operating Navy force is treated as fixed). If there are no feasible solutions because of budget or other constraints, JCS may reduce or reconfigure this set of tasks.

2. All operating system output levels are treated as either meeting or not meeting the minimal operation requirement (fulfilling JSOP objectives). Performance beyond the threshold required for the task to be considered complete need not be considered.

3. Technology is assumed to be constant within a given management cycle.

4. Optimization of billet allocations is done on a one-cycle basis. However, the projected 5-year defense needs act as a constraint on the achievement of this solution.

5. Optimization of man-machine, recruiting/training, and hardware/logistic type tradeoffs is constrained to within (vs. among) programs, weapon systems, etc.

6. Multiple ways of accomplishing objectives at the threshold performance levels are assumed to exist (i.e., tactics are variable within the planning time frame). These alternatives are specified in terms of the manpower resources in this conceptual model. However, alternative configurations could also be specified with respect to the equipment, training, and logistics variables.

This last assumption of alternative manpower configurations implies that certain categories of manpower are substitutable. This substitutability is based on similarity of effect on a mission rather than similarity of task elements. That is, different types of manpower may perform in different ways. However, if they have equivalent effects on mission accomplishment, they should be treated as identical within the model.

The objective of the model is to accomplish the JCS objectives at minimal cost through the most effective allocation of resources to programs, subject to applicable constraints. That is, find x_{ij} (i = manpower type^1, manpower type^2, ... manpower type m; j = program^1, program^2, ...program^n) in order to minimize

$$\sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij}$$

where c_{ij} is the cost associated with allocating resource i to mission j and x is the number of resource i allocated to program j, subject to:

1. Budget constraints,
2. Mission constraints,
3. Organizational constraints,
4. Manpower constraints,
5. Personnel inventory constraints, and
6. Technological constraints

The technological constraints describe the alternative ways of utilizing manpower to achieve mission objectives (as defined in the JSOP, Volume II). The objectives, the output tasks performed by the operating forces of the Navy, may be represented at various levels of detail (e.g., program, activity, weapons system). The nature of the problem suggests that a linear programming form might be the best way to represent the system for solution. However, there are two important structural differences. First, a rather unusual constraint must be imposed on the coefficients in the objective function, viz., the first assumption. All the outputs must be produced and no more than one of each is necessary or acceptable. Thus, all the coefficients must be set equal to one. If any are greater than one or are equal to zero (all must be integer), the solution is infeasible. Second, the nature of this allocation problem dictates that more than one possible production function be considered for each of the outputs.

Thus, there are multiple ways of producing each output and the various outputs use common resources. Solving for the optimal manpower configuration requires the selection of the set of production functions which minimizes the costs of manpower across all objectives (outputs). Optimization in terms of single objectives (i.e., choosing the least-cost manning configuration for each objective) may not provide for a global minimum.

IMPACT OF SYSTEM BOUNDARY DEFINITION

As mentioned above, this is a conception of the problem which is several times constrained. The assumptions which underlie the model bound the system at the Joint Chiefs of Staff on the upper side and at the activity level on the lower side. Certainly, as these bounds are pushed outward, the number of variables increases and the constraints are loosened (although new allocation problems surface).

If the upper boundary of the system was pushed higher, say to the OSD level, the nature of the problem would remain essentially unchanged. There would, however, be a leap in the number of outputs included in the problem objective function. Additionally, there might be an increase in the number of different possible production functions per output, since the OSD model would presumable accommodate interservice tradeoffs on the performance of certain missions. The budget constraint and the manpower ceiling constraint would remain essentially unchanged in form, but would increase in magnitude. All the assumptions necessary to support the OPNAV level model would be retained in the OSD level analysis.

Of course, the OSD level analysis could proceed at the strategic rather than the tactical level. This would involve an agglomeration of tasks into supertasks, i.e., strategic objectives. The basic structure would again remain constant. A tradeoff would have been made, however. Specificity in the production functions would inevitably decrease while "manageability" of the model would improve as a result of trimming the number of alternative production functions considered.

Having established the bounds for the systems analysis at the OPNAV level and articulated a model of the underlying problem situation, it was possible to move forward with the design of a data collection instrument. The purpose of this instrument had to extend beyond the simple mapping of the Navy manpower planning system. The need for a mechanism to assemble the data required for measurement of system effectiveness was also recognized, and the two requirements were merged.

RATIONALE FOR THE DEVELOPMENT OF A DATA COLLECTION INSTRUMENT

In order to gather information necessary to describe the management system thoroughly, a dual effort seemed to be required. Attention was directed toward a complete review of existing documentation on the system under study (Wedding & Hutchins, 1974), as well as to the development of a data collection instrument to draw perceptual information from the individuals participating in the management process as it actually operated at the time of the analysis. Of course, great disparities were expected to exist between the images of the system developed in these two efforts. Discussion of the nature of these disparities should reveal the reasoning behind the decision to compose the data collection instrument in the form it ultimately assumed.

First, the formal documentation may not be sensitive to the particular individuals filling positions within the management system. Different people with different backgrounds might perform the same task in different ways. This could include contacting different people for the same information as well as sending output information to different people or to the same people in different formats, etc. The possibilities for variation are myriad. The advantage of the instrument is that it facilitates exposure of the actual operating rhythms of the system, including both the formal and the informal communications networks. It is flexible enough to allow for the impact of personalities. Also, while the accuracy of a particular system description diminishes as new personalities fill the system billets, the capability to update that description by reapplication of the instrument at various points in the future would always exist.

Thus, the information gathered by the data collection device should reflect the way the system really works at a point in time. The formal documentation, on the other hand, is likely to reflect a more prescriptive view. It specifies the manner in which the system was supposed to have worked at a particular point in time.

Additionally, the formal documentation does not provide a basis for either cost-effectiveness or cost-benefit analysis with respect to either the entire system or components within the system. The instrument answers this requirement by soliciting responses from system participants about the perceived benefit of both their inputs and their outputs as well as about their production resources, i.e., costs. These data, though far from satisfying the conditions for complete economic analysis, provide a first step towards specifying the marginal revenue products of various intermanagement system information products some time in the future. If such an analysis could be completed, the management system would be provided with a powerful tool to assist it in allocating its own resources (people, equipment, time, etc.).

Finally, the instrument should enable a more complete description of given information packets to be developed. It inquires into the exact nature of the information content (i.e., is it quantitative?, is it actual data or projected figures?, is it a specification of resource constraints?, etc.). It inquires about the operational context in which the organizational element is functioning (i.e., a resource claimant?, a system sponsor?, etc.) in the production of any given information packet. It inquires about the perceived tone of both inputs and outputs, as well as their frequency, variability, feedback nature, etc. Finally, the instrument is designed to collect data on the kinds of decision-making processes used by the organizational components in forging their information outputs. Few of these types of descriptive data are available in the existing formal documentation.

INTERVIEW FORMAT VS. QUESTIONNAIRE FORMAT

The instrument was cast originally as an interview. It remained in this form for a number of contacts with system participants. After this initiation, it was determined that a questionnaire format would be more fruitful.

Some of the advantages of the interview format were:

1. It provided the respondent with an immediate feedback channel – the interviewer – to clear up any questions on terminology.

2. It made it difficult for the respondent to avoid answering questions which might prove uncomfortable, say in the cost and benefit areas.

3. Once the interview was started, there was a high probability that all the data would ultimately be collected (whereas questionnaires could be dropped and walked away from at any time, never to be completed).

4. It provided the analysts with a direct interface to system participants, enabling them to weed out questions which looked eminently useful in the laboratory but appeared too esoteric to respondents. This advantage, of course, applied only during the developmental period. Once the question set had stabilized in form and content, such modification was no longer required.

These advantages were outweighed by a number of serious deficiencies which soon became apparent to the anlaysts collecting data in the operating management system. Because the interviewees were active managers with a multitude of demands competing for their time, the analysts were required to spend considerable time on the telephone arranging and rearranging interview times and sites. Added to this were travel time and, of course, the considerable amount of time required for the interview itself. All of this amounted to an overwhelming demand on the scarce manpower resources available to the project. Since the questionnaire approach allowed a more frugal allocation fo project manpower to the data collection task, it appeared to be the most desirable.

The second deficiency represented the obverse of the first. Busy participants had considerable difficulty in breaking away from their work for a long enough period of time to do justice to the interview (which required anywhere between 2 and 6 hours for conscientious completion). It was observed that the quality of the answers seemed to deteriorate markedly over the course of the interview. The questionnaire format allowed the participants to pick up the effort whenever it proved most convenient to their own schedules. Thus, they could deflect their thoughts to intervening "crises" by laying the questionnaire aside whenever other tasks pressed for attention. To prevent this "laying aside" from becoming permanent, the analyst was forced to be persistent in his follow-up contacts, always attempting to gèt the manager to set some reasonable deadline date for questionnaire completion.

Finally, the presence of the interviewer interjected a source of bias into the process. Different interviewers tended to place their own emphases on various sections of the inquiry. Such emphases were certainly likely to bias the answers provided by the interviewee (especially if he was impatient with the length of time required). The questionnaire avoids this process to some extent by presenting the same information to each respondent. Every participant thus proceeds within a common framework, answering the questions in the same order.

For these reasons the questionnaire format was adopted. Using the systems reference developed in the study of the formal documentation (Wedding and Hutchins, 1974),

points of entry into the system were selected and the questionnaires distributed at these points. Once returns began to come in, it was possible to identify other parts of the system requiring attention simply by examining the lists of input sources and output destinations on the completed questionnaires. Proceeding along these lines, it was possible to specify and to contact the pertinent decision-making, information-processing units in the Navy manpower planning system.

STRUCTURE OF THE QUESTIONNAIRE

The questionnaire has been included in this report as Appendix A. It is the purpose of this section to discuss the contents of each section of the questionnaire. This discussion is meant to reveal the purposes behind the inclusion of each question and its relationship to the entire data design.

THE INTRODUCTION

This section of the questionnaire is important in providing the respondent with an appropriate frame of reference for answering the questions. In doing so it performs the following six functions:

1. It identifies the interest of the Navy Personnel Research and Development Center in the areas of personnel management and manpower planning. This is expressed in terms of a desire on the part of the Center to establish a solid foundation of knowledge about the detailed operations of the manpower management structure as a basis for future developmental efforts.

2. In line with this desire to create an accurate portrait of the management system, the introduction reflects the concern of Center analysts that ideas for improvement of the system held by participants should be assembled and considered prior to an initiation of developmental efforts.

3. Because some of the questions about resources costs and perceived benefits could appear threatening to some participants, the introduction stresses the fact that the information gathered is not to be used to evaluate performance of individuals.

4. A brief explanation is provided of the conceptual model employed by the analysts to structure the questionnaire.

5. The introduction specifically recognizes the problems of aggregation that some respondents are likely to confront. It encourages the participants to use their own judgment in combining inputs or outputs for description in the questionnaire when they appear to be similar in form, purpose, source, or destination. By placing the focus of the analysis on POM related activities, however, the introduction encourages the maximum degree of disaggregation and specificity possible within the time constraints of the respondent.

6. Finally, it is noted that the respondent may perform a variety of functions related to affairs other than manpower planning. Participants are urged to focus solely on those activities which relate to manpower planning, listing only the inputs and outputs which pertain to those activities.

Since the questionnaires were hand-delivered, the information contained in the introduction was generally supplemented by a short discussion with one of the project analysts. At such meetings, the explanation of the input-output was expanded upon. In addition, these meetings often provided a forum for the respondents to confirm for themselves the importance of the research effort and to gauge any impacts it was likely to have on their own positions. Needless to say, the path tread by the analysts at these meetings was a precarious one. It was as important to avoid a threatening approach as to avoid the kind of approach which failed to stress the urgency of each respondent's full and immediate cooperation.

BACKGROUND INFORMATION

In this section of the questionnaire, the objective is to place the individual node (be it a single individual or some group of individuals) in its proper organizational context. This information was gathered with the possibility in mind of ultimately assembling some kind of "organizational directory" of individuals and offices involved in Navy manpower planning.

The participant was asked to identify the point of view which he was assuming in his reactions to the questions. This was necessitated by the lack of uniformity of perspective which was observed during the interview trial runs. Some respondents were casting their observations only in terms of what passed through their own desks, whereas others were speaking for their groups, branches, divisions, etc. A grasp of perspective was necessary in making a precise judgment about the specificity of the answers provided.

Two other important pieces of information were requested in this section. First, the respondent was asked to provide the length of time he had been employed in his position. Consideration of this variable across all respondents would provide the analysts with a gauge to measure rate of change in the information communications network. This reflects the hypothesis that the personnel change rate within the management system may be inversely related to its effectiveness at high rates. Second, the respondent is asked to identify how long the particular function he performs has been in existence. This leads to the specification of a second change rate – this time a structural rate. As the two rates increase, the stability of the process is decreased. Since it was felt that stability may be related to performance (i.e., in periods of turmoil, both organizational effectiveness and efficiency drop off), these questions were regarded as important.

Questions which define two other change rates appear in a later section of the questionnaire. One of these concerns the continuity of information channel maintenance and operation. The other concerns longevity of processes employed in component information processing. Combining all these rates, the analysts are able to express an index of organizational stability which reflects both personnel and structural dimensions.

IDENTIFICATION OF INPUTS, PROCESSES, AND OUTPUTS

This section lays the groundwork for the completion of the rest of the questionnaire. It provides the opportunity for the respondent to visualize the framework of his operation in terms of (1) the information outputs which he produces, (2) the processing algorithms which he employs to shape these outputs, and (3) the information inputs which are the raw materials for his production process. An output is listed and coded with a number which is to be used whenever that particular output is referred to in the rest of the questionnaire.

Likewise, the inputs are listed and coded with letters. Finally, space is provided for enumerating the processing modes used in producing the various outputs. The respondent is asked to depict the relationships of the various inputs to particular outputs by drawing arrows from the inputs through the processes to the outputs with which those processes are associated. The respondent is instructed to remove this sheet to assist him in answering the rest of the questionnaire (with a reminder to return it along with the rest of the pages when his response is complete). It provides a concise display of the role of the respondent in manpower planning.

An example of such an input-output flow sheet is then provided to aid the respondent in his effort to represent his functions. This example is constructed to demonstrate the analyst's interest in informal communications as well as the more formal, system-prescribed communications. "Review," "analyze," "evaluate," etc. are indicated as acceptable for the purposes of this project.

INPUT, OUTPUT, AND PROCESS SPECIFICATION

In this section, the respondent is asked to flesh out the description of inputs, processes, and outputs described in the flow map. Specifically the respondent is asked for a brief description of each communication, along with an identification of sources (in the case of inputs) or destinations (in the case of outputs). This descriptive information enables the analysts to make produced-consumer "matches" with a higher degree of certainty. In other words, the analyst can more readily determine that the output described by one unit directly corresponds to an input described by another unit. Matching these two descriptions of the same communication opens numerous opportunities for interesting comparisons of producer and consumer perspectives on different dimensions of that communication (e.g., benefit, purpose, tone, etc.).

Also, with respect to communications, the respondent is asked to indicate the length of time (in years) the contact has been maintained (i.e., the continuity dimensions described above). This indication of how long the particular channel has been in operation enables development of one more change rate. It reflects the stability of the communications network in supporting the information-processing activities in various sectors of the system. Another change rate is specified by the answers provided to the questions concerning the length of time each of the processes has been performed. In any case, both rates are structural in nature and can be combined with the change rates discussed earlier to develop a rough index of organizational stability.

Again, it was hoped that the descriptions of processes provided by the respondents would not reflect self-consciousness about the lack of a "sophisticated" technique. The analysts were concerned about the ability of respondents to set down in writing a description of their methods, which had perhaps never been articulated before. However, the scope of this study precluded the development of a more refined set of questions to capture these methods. It was felt that thorough analysis of the operations of particular units of the system would be more appropriately deferred until such time as the Phase I system study was completed and the critical components of the entire system had been identified.

CLASSIFICATION

In the classification section, the respondent is asked to identify the kind of information which is contained in each communication input or output in his list. Using these data in conjunction with the data collected in the costs-benefits area, the analysts will be able to assess which kinds of information the entire management system can effectively produce and which kinds (if any) it cannot.

Accordingly, a typology was developed to classify the information content of communications. Seven different kinds of information were specified in this typology:

1. Environmental Forecasts
2. Performance Evaluation
3. Structural Information
4. Quantitative Information
5. Procedural Specifications
6. Specification of Management Resources
7. Documentation

These categories are intended to include various kinds of information required by decision makers. Because it was recognized that particular communications could contain more than one kind of information, respondents were not restricted to any set number of category checks. During the period in which data collection took an interview format, interviewers were instructed that, for any given output (i.e., decision), an individual would generally require input information of each of these seven types. Accordintly, the interviewer was to be mindful of the need to have the respondent discuss the source of each of these information types if he did in fact receive them from units outside his own. This charge on the interviewer established a framework for achieving a complete enumeration of the information input source of the respondent, perhaps expanding the list described by the respondent in his input-output flow map.

The following explanations and their accompanying examples were offered as an attempt to clarify the definitions of the communication typology for the benefit of the interviewers.

1. Environmental Forecasts: These communications often take the form of suggested operational scenarious, which can be either qualitative or quantitative. An example of such a message might be:

> "There is a .50 probability that conditions will require 7 men in the computer room, a .35 probability that at least 10 men will be required, and a .15 probability that the workload will only require 5 men."

An alternative statement describing the same situation (which would also fall under this category) might read:

> "Depending upon variances in the workloads and/or complexities of the tasks which will have to be performed, the actual requirements for manpower in this environment could vary between a minimum of 5 and a maximum of 10."

In a less tangible vein, a forecast of general economic conditions (the employment rate, for instance) might be included in this category. Such communications may or may not be accompanied by a statement concerning the approach toward risk which is appropriate to the situation. In any case, this kind of communication might be input to an individual tasked with producing quantitative information for some other network node (thus performing a preprocessing kind of function for this other node).

2. Performance Evaluation: The communications in this category can be broadly classified as feedback. They contain information concerning the degree to which a node's products met the needs of its consumers (i.e., the satisfaction of the consumers). Feedback from the operating system would be included here, as would information on the degree to which consumers' needs have been met, suggestions for changes in kind or emphasis of elements included in a node's output, general statements or statement of satisfaction or the lack of it, etc.

Often this kind of communication will be of a more informal nature, transmitted from immediate consumers to the producing node being studied. Formal recommendations for processing alterations can be generated almost anywhere in the system at any time that poor performance in some area is noted. There may or may not exist regular program review cycles which attempt to stimulate generation of such communications.

3. Structural Information: Communications in this category indicate the operating system elements or characteristics a node must consider in performing its processing tasks. For example, if the task of the node is to allocate manpower in the Navy to a particular kind of function (say, computer operations and programming), a number of factors must be considered. These could include the nature of the equipments which must be operated, the costs of different types of manpower in terms of skill and longevity, training and pipeline costs, the expected capabilities of qualitatively different kinds of manpower (i.e., a DP as opposed to a DPC), and manpower and budgetary ceiling. The elements to be considered may fall in the area of process objectives, process constraints, or the necessary relationships between resources consumed by the process. All of these might be somewhat intangible. For instance, an element to be considered in the objectives set might be the maintenance of as much flexibility as possible.

4. Quantitative Information: Communication in this category serves to attach values to the elements identified under the structural information area. These communications necessarily contain numerical data (quantities in the case of constraints or production functions, or values or costs in the case of objective functions).

Some examples would be tables of data containing personnel costs by grade and/or skill category, actual workload figures in a work units/hour format, manpower ceiling (stated in terms of grade structures, for instance), budgetary ceilings, etc.

Often these data will be combined with structural information. Sources for structural information may be superiors in the organizational hierarchy, while the sources for quantitative information will often be subordinates or other organizational entities outside the chain of command in which the observed node resides.

5. Procedural Specifications: Communications included in this category are descriptions of the way things should work in the management system. A good example is the Navy Programming Objectives Manual (a SECNAV document) which prescribes certain management communication patterns and functional procedures. It also defines the authority and responsibility of each of the constituent parts of the total management system. Directives which contain instructions to perform particular processing functions at a given time

or requests for authority to perform these functions would fall in this area. Since this is a military organization, almost any request for information from subordinate entities within the total system could be considered an action instruction (thus, a procedural specification).

Roughly, any communication may be placed in this category which tells one who to see for information, what he must get from them, what functions he must perform, when he must perform them, or where he must deliver his output. They might best be described as the operating instructions which govern the functioning of the entire network (or of subsections of the whole).

6. Specification of Management Resources: These are communications issued by the management system administrators which allocate resources (time, clerical and professional manpower, equipment, money, etc.) among the processing units. Some examples of these types of communications would include: (a) manpower ceilings applicable to the processing unit, (b) time schedules for the performance of tasks, (c) organizational budgets, and (d) approval for the utilization of computer resources. There must be someone in the total system who makes these decisions relative to each individual processing unit. It is important to find out who this authority is so that we can then attempt an analysis of the basis on which these allocations are made.

7. Documentation: These communications are produced in order to explain to persons outside the processing unit what processing steps lead to the unit's outputs. They may be produced for the benefit of almost anyone in the system, but they are generally designed to aid future occupants of the billets within the processing unit in learning and performing their tasks.

Examples of such communications are the manuals which explain the operation of the Navy Resources Model (NARM)* and the theory supporting it. The purpose of these manuals is to express the processing strategy of the network node which administers the operation of the NARM. It is expected that documentation communications will exist for all such formal models employed by any processing unit. In any case, there are two reasons why it would be useful to be able to uncover such communications: (1) To extend the effort of last year, oriented to determining the state of the modeling technology in manpower/personnel management (Hutchins, 1974), and (2) to procure the documents. The latter should significantly enhance our understanding of the manner in which the processing unit functions.

Naturally, the above descriptions could not be provided to the respondent when data collection moved into the questionnaire mode. Therefore, the analysts provided brief descriptions of the information types and a means for the respondent to easily classify particular communications inputs and outputs by checking appropriate boxes beneath the communications codes they themselves had assigned on the input-output flow map. These brief descriptions involved a presentation of groups of examples for each of the categories. Additionally, the respondents were invited, in an eighth selection possibility, to specify some other category if none of those listed appeared to be accurate for the description of a particular communication.

The categories, as they appeared in the questionnaire, were defined as follows:

1. A scenario, projection, forecast, or material containing "what if" questions or answers.

2. A review, evaluation, feedback, sanction, concurrence or nonconcurrence, or reclama.

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* The Navy Resources Model (NARM) is maintained by an office under the Director of Navy Program Planning (OP-090). The model is a device for estimating total resource requirements and cost implications associated with alternative force structures and operating modes.

3. An identification of variables, factors, or problem elements; or a structure for considering them.

4. Quantitative information or numbers associated with problem elements.

5. A direction, statement of policy, or procedures to be followed.

6. A specification of available resources or resource constraints.

7. A document of a processing method, technique, or approach.

8. Best described by some other category. If so, what?

Since respondents were asked to make classifications for both inputs and outputs, the path was laid for consumer-producer comparisons in terms of perceptions about purposes for particular communications. As mentioned previously, the combination of these classifying data with cost-benefit data would enable analysts to make judgments about the effectiveness of the system in creating and processing each of the different kinds of information products perceived as necessary to system decision makers.

DESCRIPTION

The section described herein was included to ascertain the format, tone, frequency, variability, and feedback characteristics of identified communications. As in the section above, the respondent is requested to check boxes for affirmative responses, again utilizing the communication codes assigned on the input-output flow map.

In order to characterize the format of a particular communication, the respondent is asked for a yes or no answer to the following inquiries:

Is the information . . .

1. Prescribed (formal)?

2. Written?

3. Routine?

4. Request?

5. Response?

Affirmative answers to the first three of these questions would imply that the communication channel was of a more permanent nature. As this triad tends toward negative responses, the information channel would seem to be more ad hoc or, perhaps, more a function of the particular person occupying the organizational slot than of the slot itself.

The questions about "request" and "response" are posed in order to determine a direction of initiative between the respondent node and the node with which it communicates. These data should assist the analysts in identifying broad information flow paths which channel the decision inputs to the ultimate decision makers in the system.

A second set of inquiries encourages the respondent to place the communication somewhere on a "tone" scale, which ranges in intensity from "suggestion" to "command." The complete order of presentation is as follows:

1. A suggestion

2. A recommendation

3. Guidance

4. A directive
5. A command

It is expected that the tone of a communication increases in intensity as one moves from "suggestion" to "command." Answers to this question set should prove interesting in the analysis phase wherein producer and consumer perspectives of the same communication are contrasted. This group will also be useful in establishing the lines of perceived authority and responsibility within the network.

In order to determine the frequency with which a given communication is sent or received, the respondent is asked to indicate whether a linkage is established on a weekly, monthly, or annual basis, or whether it is only established on request. This question is vital to the objective of graphing the system's information flows on a time axis. Additionally, a means is established for assessing the importance of particular functions of given nodes on the basis of the amount of time spent performing those functions.

A question is asked about whether or not the communication exchange is "accompanied by substantial informal dialogue." This information will aid analysts in making a judgment about the adequacy of feedback mechanisms within the manpower planning system. Such mechanisms are often informal, which is the principal reason for including this question. (It was feared that such informal dialogue at the communications interface would not be reflected on the input-output flow map.) However, whether formal or informal, feedback channels provide the sole means for components of the system to evaluate their own performance and thus are critical to the operation of the system.

Finally, a question is asked about the variability of the information content of the communication. This question is rough hewn. The respondent is asked for a global judgment as to whether the kind or quantity of the information incorporated in a given communication varies more than 20% from one year to the next. Here, the intent is to get at the variability of communications over time, without particular concern for isolating the source of that variability.

It was the hypothesis of the analysts that more variable communication contents might be more important to system decision makers than would the relatively constant contents. The assumption is that a decision maker is more sensitive to the more variable decision inputs. Thus, one might expect that more variable communications would be rated with higher potential contribution values than the less variable communications. In any case, the respondent is only asked to determine whether or not variability exceeds 20 percent. If so, the communication is considered to be variable. If not, it is considered to be constant.

RESOURCE UTILIZATION

The first part of this section is concerned only with the inputs which the respondent receives. He is asked to rate them on 0-3 scales describing accuracy and satisfaction with wait time. As described below, the questionnaire attempts to elicit judgments from the respondent concerning his general satisfaction with particular inputs in the benefits section. These two questions might serve the purpose of partially explaining expressions of relative dissatisfaction in the general benefits area.

Accuracy, the first attribute examined, can be rated on the following scale:

Not accurate	0
Accurate some of the time	1
Accurate most of the time	2
Always accurate	3

Wait time is the second attribute, and it, too, is scaled on a 0-3 basis.

Not satisfactory	0
Satisfactory some of the time	1
Satisfactory most of the time	2
Always satisfactory	3

It might be hypothesized that, as these measures tend toward the upward end of the scale, the general benefit measure would tend to increase. Should this not be the case, accuracy of the communications and their promptness of delivery may not be the most important aspects of given communications in the minds of the respondents.

On the output side, respondents are asked to specify the manpower resources which are actually applied to the production process for each output communication. Manpower is divided into four cost classes: officer, enlisted, civilian professional, and civilian clerical. After the number of man-years of effort incorporated for each manpower cost class has been determined for a particular output, the total cost of producing that output can be computed by multiplying average life-cycle cost for a man-year of effort in each class by the total number of man-years consumed and then summing across classes.

In this computation, average cost figures were selected as opposed to actual cost figures for the particular people currently filling the billets. By utilizing the life-cycle cost (i.e., salary, leave, benefits, training, and retirement), means for each organizational component within OPNAV were computed for each of the four labor cost categories. Averages across the component means for each of the labor cost categories were then computed.* These appear below:

Labor Category	Average Life Cycle Cost (Man-Year)
Officer	$56,000.00
Enlisted	$19,500.00
Civilian Professional (GS-7 and above)	$27,700.00
Civilian Clerical (GS-6 and below)	$11,400.00

These values were used for the manpower cost computations of the individual components, since the deviations from these means attributable to organizational element affiliation were relatively small. Additionally, this reduced the amount of detail that was required from the respondent. Instead of having to specify the persons who worked on a particular output and for how long, the respondent was only required to provide estimates of the man-years of effort involved by labor cost category. Most of the respondents could readily produce such estimates.

*A more complete description of data sources used as a basis for these life cycle cost computations has been described in a recent report (DiGialleonardo and Barefoot, 1974).

One aspect of the cost analysis, which should supply some interesting perspectives on management system resources control, is the shared cost computation. Once the total cost of producing a given information product has been established, it would be useful if that cost could be allocated among the consumers of that product. This would enable meaningful cost-benefit analysis on the information packages traveling along the system communications network. For the purposes of this initial investigation, shared costs were developed by dividing the total number of consumers of a given product into its total production cost. It was recognized that some consumers might be willing to pay a good deal more for the product than this shared cost figure. Others, of course, would not be willing to pay as much, or, perhaps, anything at all. They would only take information because it is free. In any case, this shared cost analysis would seem to merit further development work directed toward constructing a better cost allocation mechanism.

After having specified the actual manpower resource utilization for each output, the respondent is asked for his opinion about whether or not a more ideal allocation could exist and just what that allocation might be. Thus, "ideal" total costs and shared costs can be computed in the same fashion as were the actual figures. Such data promise to be the most useful at the point in which the descriptive effort is phased into the prescriptive effort and recommendations for reallocation of management system resources would be in order.

While it was recognized that there were other resources employed in the production processes for information outputs (particularly ADP equipment), the decision was made that it would not be feasible to incorporate these resources into the cost analysis. On the one hand, respondents were likely to be hard pressed to summarize accurately the amount of such equipment utilization in a manner consistent enough across components to allow for meaningful handling of those data by the analysts. Also, it was felt that manpower costs would make up the bulk of total costs of such production functions.

PROCESS

This section represents an attempt to gather data necessary to place information output events into a temporal framework. The respondent is asked to indicate whether or not his outputs are produced as part of some organizational cycle of activity (planning, programming, etc.). If it happens to be a regularly scheduled product, a request is made for cycle name and length. Such data are useful in relating components of the process to each other functionally, as well as in a temporal context.

Another data element requested here reflects upon the "criticality" of various communications within the system. If the system could be modeled as a PERT type network, it would be desirable to specify which events in the system necessarily preceded certain other events or, in other words, which events were on the critical path through the network. The questionnaire approaches this by asking for the triggering event or communication for each of the outputs produced by the respondent.

Finally, the respondent is asked to provide a brief description of the process utilized to produce each of the outputs. If a commonly recognized problem-solving technique is not employed, the respondent is asked to be somewhat precise in delineating the steps which he consciously takes in order to reach his conclusions.

SPONSOR

Much of the business of the Navy manpower planning system proceeds along functional lines within various sponsor contexts. Participants in the system understand these functional partitions and tend to perform separate information production tasks within one or another of these broad functional areas. Accordingly, to translate the language of the systems analysts into the language of the manpower-planning participant concerned with organizational identities, respondents were asked to label each output with a sponsor context and a name for the related mission, task, appropriation, etc. Included among the possible alternative "contexts" were:

1. Major mission sponsors
2. Force function sponsors
3. Appropriation sponsors
4. Program element sponsors
5. Navy-wide support sponsors
6. Program sponsors
7. Military manpower claimants
8. Others (specify)
9. OCMM-related
10. Not familiar with sponsor context

An accurate description of the meanings of these terms is available in a recent report (Hutchins, 1974). In this document, the importance of these functional categories to the manpower planning process is fully developed. For the purposes of this report, it can be noted that these data enable a useful cross tabulation of functional specifications and cost-benefit criteria.

BENEFITS

The benefit model utilized in this system analysis to anchor cost-effectiveness type judgments has been explained in another report (DiGialleonardo & Barefoot, 1974). Because of the importance of the benefits data to the total framework developed by the questionnaire, the substance of that report will be briefly summarized here.

Benefit is approached as a subjective value and is composed of three elements. The first of these elements is potential contribution. In rating potential contribution, the respondent is asked to indicate on a five-point scale (see table below) the magnitude of positive effect that each input would have on his process if it were in some sense ideal or perfect.

No contribution	0
Low contribution	1
Moderate contribution	2
High contribution	3
Very high contribution	4

This rating of potential contribution reflects the emphasis which the respondent would place on the input in his process if he felt that it was ideally composed. In the case of his own outputs, he is asked to put himself in the shoes of his consumers, rating the potential contribution of his product(s) to their processing needs. This is a difficult judgment to make and requires careful thought. In a sense, the respondent is required to rate his own tasks for their importance to the whole manpower planning process.

The second part of the benefits model is received value. In this rating, the respondent must move from the ideal world to the "real" world. In the case of his inputs, he is asked to describe (as a percentage) the amount of the ideal value of a communication input which is actually achieved by its producer. He may feel, for instance, that the information he receives meets its full potential. In this case, he would give it a 100% rating. Any reasons for dissatisfaction or diminished confidence in an input would be likely to decrement that percentage. No immediate effort is made to ascertain the attributes of the information which are responsible for such feelings (although the earlier questions on input accuracy and wait time satisfaction could be considered as such).

In the case of his outputs, the respondent is being asked to rate his own performance in completing the tasks assigned by the system. Although a bias toward high percentage ratings might be expected here, this tendency might be mitigated by the opportunity presented to the respondent earlier in the questionnaire to comment on his satisfaction with his own resources allocation (especially manpower).

Utilization value is the third part of the model. On the input side, the respondent is asked for a percentage of received information which he is actually able to assimilate in his process. This again provides the respondent with an indirect means of expressing dissatisfaction with his own resource constraints, i.e., time, equipment, manpower, etc. On the output side, he again must assume the identity of his consumers, rating the amount of his own production which is really utilized by them in their manpower planning tasks.

The three values indicated by the respondent are subsequently multiplied together. The resulting product represents a computed benefit value which can be utilized with the cost figures developed earlier to perform rudimentary cost-effectiveness calculations.

Next, the respondent is asked to rate overall benefit of a given communication in relation to the manpower/personnel management process in general, considering any factors felt to be relevant. As in the case of potential contribution, this is to be represented on a five-point scale running from "no benefit" (0) to "very high benefit" (4). This question was included to provide a check on the tripartite benefit model above described. Presumably, the rating of overall benefits should correspond to computed benefits for each respondent.

Since respondents are only asked to comment on communications as they are used in manpower planning processes, a question is posed about whether a respondent is aware of uses for these communications in other management areas. Such data are necessary to supplement the benefits model's value as a basis for determining the net worth of particular communications. Obviously, the total benefit of any communications which are utilized by participants in other management processes will not be determined by examining the group of participants only as they are involved in manpower planning.

Finally, a direct question is asked about "benefits" feedback. In the case of inputs, the respondent must indicate whether he expresses his satisfactions or dissatisfactions to their producers. In the case of outputs, he is asked to indicate whether the basis of his perceptions about the benefits of his own products is information channeled back to him from his consumers. Feedback channels are characterized by the frequency of their use:

No feedback	0
Feedback sometimes	1

Feedback most times	2
Feedback all the time	3

The attempt to explicitly define all feedback channels focuses on the relationship between decision-making and decision implementation at all points within the information-processing mechanism. It reflects the belief that decisions which are serial in nature (i.e., the same "kind" of decision must be made over and over again under altered environmental circumstances) may benefit from the availability of historical data on performance. If such data are not available to the decision maker, his ability to evaluate the appropriateness of his model or its underlying assumptions could be seriously limited, and the quality of his results might deteriorate over time. If feedback situations exist within the system, correlation of the results of this feedback question with the benefits data should establish the importance of feedback information in the minds of the system participants.

COMMENTS AND RECOMMENDATIONS

As promised in the introduction to the questionnaire, the views of the respondent are solicited concerning potential improvements which could be made in the management system. The questions invite open-ended answers. First, the respondent is asked whether he can think of any additional inputs which might be useful in his own processing modes. If so, he is asked to describe the input, state how it would be used, and identify a probable source for that information. In the case of outputs, he can describe any information products which he could produce to supplement those which are already listed on the input-output flow map. Additionally, he is asked to indicate what would be the probable use of this information, whether it is presently available (if so, from what source), and whether significant additions to present resources would be necessitated to produce this information. All these data should be applicable in future diagnostic efforts. They will assist in the identification of gaps in particular kinds of information and gluts of other kinds. They will underscore the previously made statements of participants concerning the kinds of information which, from their perspectives, appear vital to the functioning of the Navy manpower planning system.

Finally, the respondent is asked for any general reflections he might have on the nature of the manpower planning process and the potential enhancement of its performance through some change, organizational or otherwise. This again is open ended, and the respondent is provided with plenty of space to expand upon any observations he might have.

VALIDATION OF THE QUESTIONNAIRE APPROACH

The questionnaire is designed for the purpose of discovering the working components of the system in their operational interrelationships. Reasonable assurance must be provided that the diverse motives of system participants will lead to minimum obfuscation. The check against such an eventuality involved presentation of like sets of descriptive and evaluative questions to both consumers and producers of information. Additionally, it was expected that the requirement of each respondent to wear the shoes of both consumer and producer would help to attenuate biases.

In order to validate the effectiveness of the questionnaire approach in meeting the above objective, a number of tests were run with some of the early returns. As described

above, there was a measure of validation involved with the switch from the interview format to the questionnaire format. The fact that the questionnaire proved capable of evoking responses of quality comparable to that of responses gained in interviews conducted by the analysts encouraged belief that the intent of the questions was being grasped by most respondents.

Also, a number of tests were run in order to check questionnaire consistency and accuracy. A portion of the network was mapped with questionnaire responses and then fed back to the respondents for comments on the accuracy of the whole picture received from each of their individual perspectives. This same map was then compared with the system reference information flow map to measure the questionnaire's ability to uncover the skeleton of the communication network – its chain of formalized relationships. Finally, the response rate (i.e., percentages of questions answered) was examined to gauge the ability of respondents to translate the questions correctly into the language of their own functional areas.

FINDINGS

Two areas of concern surfaced in the effort to gauge the success of the approach in meeting its objectives. First, the analysts needed to determine whether the questionnaire-collected data was presenting an accurate picture of the organization under study. Second, it was important to ascertain the degree to which the kinds of information perceived as being useful to understanding the mechanics of the system's operation by the analysts were viewed similarly by managers in the operating organization. It is worth noting that these same managers are depending on the study results for identification of potential problem areas in the manpower planning and programming system.

In order to measure the success of the instrument in achieving its descriptive purpose, an experiment was conducted using the data collected from the OP-01 organization. A MARRCS project Special Report (Hutchins, 1974) describing the network on the basis of the questionnaire responses was written and fed back to the original respondents for their review and comment on its descriptive accuracy. Their response indicated that the communications flows describing their internal operations were accurate.

A second, though somewhat less persuasive, check on accuracy was performed by comparing instrument results to the network described in the formal system documentation (Wedding and Hutchins, 1974). In the case of the formal system, the mapping of the communications and their underlying functions are specified, and organizational components are identified as the performers of particular functions (i.e., as generators of formal communications). In the case of the instrument-defined network, the map is developed by combining the observations of all participants responding to the questionnaire. No prejudgments are made about the organizational elements the communication network should contain, the linkages which should exist, or the functions which should be performed in each of the various elements.

As before, the results for the OP-01 organization provided the basis for the test. If the instrument-defined network described a chain of formal communication consistent with that expected by the formal system, the questionnaire was to be judged internally consistent. (That is, it would be judged capable of eliciting appropriate respondent sensitivity to the bound of the problem area, manpower planning, and to the necessary functional interdependencies within the planning network.)

The two maps proved to be isomorphic. There was 100% agreement with respect to the flows of major documents such as MARP implementation letters and end strength control memos. Such positive results encouraged the analysts to believe that the instrument and the producer-consumer inquiry approach would be the best available methodology for systems analysis of a complex management system.

After the explanation of the questionnaire's underlying concepts by the MARRCS representative, respondents generally seemed to be able to achieve the appropriate focus on their manpower planning functions and to answer all the required questions with respect to their performance of these functions. Of almost 1,100 communications linkages defined by respondents at the time of this writing, less than 10 were describing communications outside the scope of the study.

Examining the same group of 1,100 linkages, it was discovered that only 8% of the communications described were incompletely specified (i.e., all the questions had not been answered). Of these linkages, more than one-third were the result of the fact that the question on "overall benefit" had not been included in the early version of the questionnaire which was distributed to some components within OP-01. As for the remainder of the communications with questions left unanswered, nearly all the blanks occurred in cases in which the respondent was incapable of attaching a benefit measure to the particular communication (most often in the case of outputs). Only one respondent out of more than 50 contacted at the time of this writing failed to respond to a particular question for every one of the communications he had identified (perhaps reflecting an inability to ascertain the thrust of the question). Every other respondent was able to cope with each of the questions successfully for at least one of his identified ocmmunications, which tends to indicate that the rather complex ideas underlying some of the inquiries had been transmitted with relative clarity by the instrument.

The high responsive rate, in conjunction with the high level of descriptive accuracy described above, seems to indicate that the questions were properly understood by the respondents. As to the content validity of the items involving attribute of information, there have been indications that it, too, is reasonably high. As described in a MARRCS report on the cost-benefit model (DiGialleonardo and Barefoot, 1974), the instrument appears to be doing a good job of measuring the benefits which respondents attach to particular communications. Such internal consistency will be tested for the other items by performing producer-consumer comparisons for these data elements on the full set of matched records (i.e., the communications in the system for which both producer and consumer views have been assembled). In the case of the more objective data elements (such as whether the communication is oral or written), the validity of the instrument in the sense of its measurement accuracy will be easily determined. The OP-01 analysis indicates that high accuracy is being achieved.

Finally, the instrument seems to have met the needs of individuals in an operational environment as well as members of the research community. It has enabled assembly of the necessary data to meet the requirements of the OP-01 organization to obtain an accurate portrait of the manpower planning system. This portrait should provide a baseline against which to measure the impact of any future organizational changes which OP-01 might initiate for the purpose of improving system performance, either in reallocation of functions to components or implementation of new decision-making techniques.

Also, the Assistant Chief of Naval Personnel for Manpower Information has recently employed the questionnaire to support an effort to map the information flow within the entire Bureau of Naval Personnel. This initiative came about as a result of the requirements

for reconfiguration of ADP equipment. It tends to indicate that the basic structure of the questionnaire, with a change of introduction and consideration of certain system-specific items, is applicable to analysis of other management functions. It is not restricted to the investigation of manpower planning operations.

In a similar vein, the requirements of the research community for an accurate representation of the manpower planning system, upon which to measure the impacts of future development efforts, has been realized through application of this questionnaire. Additionally, it has provided the vehicle for evaluation of a new approach to measuring benefit ascribed to information products within a management system, establishing a basis for exploration of cost-effectiveness analysis in a soft system. After the full data base has been developed and subjected to analysis, more definitive statements will be possible.

RECOMMENDATIONS

Since the scope of this report is confined to a description of the approach used in performing the MARRCS system analysis, the recommendations must be correspondingly limited. Those which can be advanced are concerned mainly with the need for further application of the data collection instrument in the interest of refining its measurement accuracy in a number of areas.

1. Among other considerations, it is recommended that this questionnaire be applied to analysis of different kinds of management systems. The work proceeding at the request of the Assistant Chief of Naval Personnel for Manpower Information is a step in this direction. Such applications should facilitate a generalization of the instrument's capabilities, making it an integral part of the Technique for Interactive Systems Analysis (DiGialleonardo, Barefoot, and Blanco, 1974).

2. In relation to such generalization, there will be a need for some further development of the prototype models embedded in the analysis. For instance, the information typology may require alteration after an examination of the patterns of answers elicited by this section of the questionnaire. Another area which may merit further effort is cost-benefit measurement. Interest has been expressed in attempting to define the attributes of communications which inspire satisfaction or dissatisfaction in an operating management system. The instrument provides an excellent framework for proceeding with such research. Additionally, the need is recognized for further work in the area of cost required (e.g., gaming). In any case, the possibilities for extension of the questionnaire-supported analyses are myriad; and the vehicle should continue in use until these have been examined and evaluated.

3. Finally, the MARRCS systems analysis approach should serve as a model for future work in other areas which necessitate a system definition. The original specification of the model of the operating system, the setting of bounds, and the focus on the generation and selection of alternatives are necessary preliminary steps which must be taken in any system definition process. The framework described in this report should prove useful in other analyses of Navy systems.

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MANPOWER/PERSONNEL PLANNING QUESTIONNAIRE

Introduction

This project is being conducted by the Navy Personnel Research and Development Center (NPRDC) as part of its mission to perform research and development in the areas of personnel management and manpower planning. CNO letter of 30 November 1973 points out the need to collect data from within the current manpower planning system and asks for support of the project.

The purpose of this particular effort is to obtain a thorough description and analysis of the processes through which the Navy currently manages manpower, especially those processes and decisions related to the POM (Program Objective Memorandum) of PPB cycle. This analysis is intended to provide a solid foundation for future developmental efforts in the manpower area both at the Center and elsewhere in the R&D community. The data collection phase of the effort also represents an opportunity for people in the manpower planning system to contribute their observations to the system development effort. This questionnaire is in no way a comprehensive job analysis or desk audit, nor does its content permit such a usage.

The questions are based on an information flow concept. The major functions that you perform or products that are produced are looked upon as "outputs" or "communications". The various types of information that are used to produce these products are considered "inputs" or incoming communications. The manner in which these inputs are used in order to produce the outputs is referred to as the process or processing technique. The format is designed to systematically ask questions in each of these three areas. If your function has a large number of inputs or outputs that are basically similar in form, purpose, source or destination, they may be grouped and referred to as one. It is reemphasized that you are being asked only to respond with regard to manpower/personnel planning and decision making information that you use or produce.

It is well recognized that the effort required to complete this questionnaire is no small task. Your consideration and cooperation is greatly appreciated. If any problems arise in completing the form please call 433-4760 (area code 202) and we will be happy to assist you.

NPRDC, Washington Branch Office, Washington, D. C.

I. Background Information

Date: _____

Name of Respondent: _____

Length of Time in Present Position: _____

_____

Name of Organization, Group or Position being described:

_____

_____

_____

Name of next lower Organization level:

_____

_____

_____

Name of next higher Organization level:

_____

_____

Number of years your function has existed:

_____

Other identifying information:

_____

II. Identification of Inputs Processes and Outputs - Throughout this questionnaire you are asked to describe (1) information or actions you produce (output); (2) techniques you utilize to produce them (processes) and (3) information upon which you base your outputs (inputs). Since it would be cumbersome to repeatedly name all of these items, you are asked to list them below as indicated and thereafter refer to them by their letter or number code. (An example is provided on the following page). Again, list only items with manpower/personnel planning implications. Provide as many items as you think appropriate. Brief names for each item will be adequate since space for more detailed descriptions is provided in the next section.

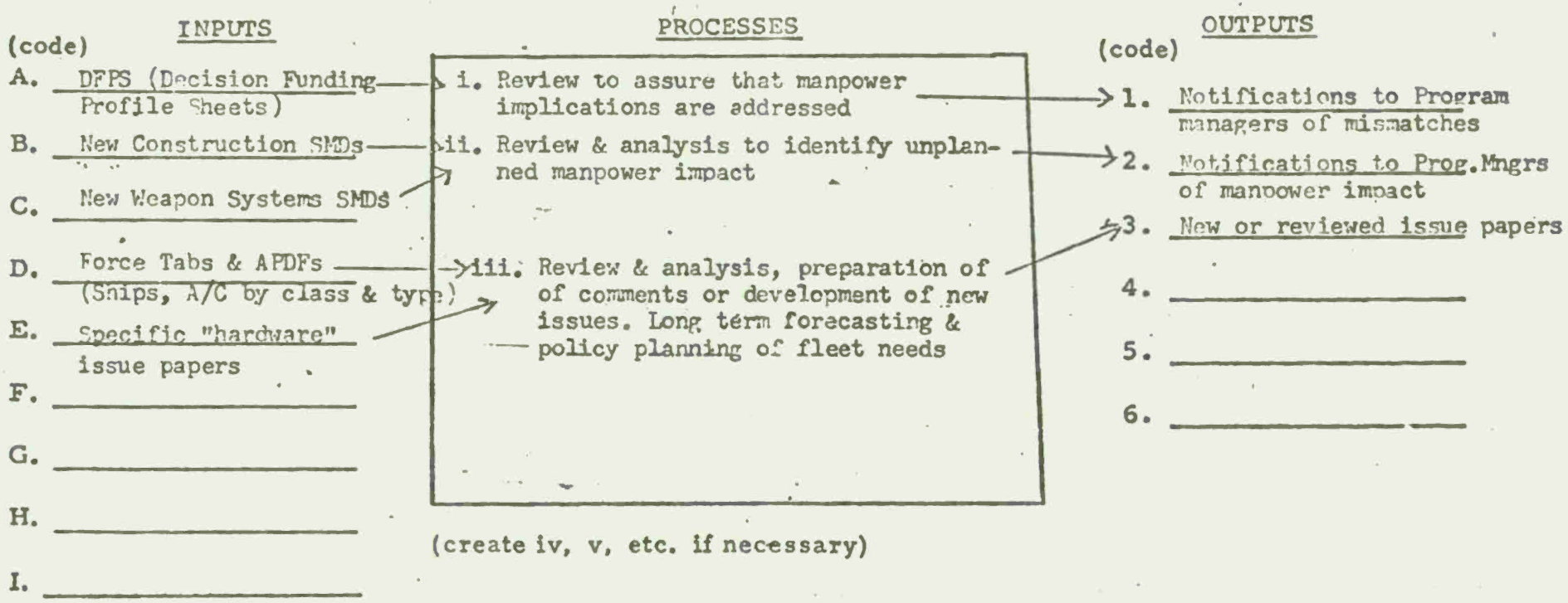
(code) INPUTS	PROCESSES	(code) OUTPUTS
A. _____		1. _____
B. _____		2. _____
C. _____		3. _____
D. _____		4. _____
E. _____		5. _____
F. _____		6. _____
G. _____		
H. _____		
I. _____		

(create iv, v, etc. if necessary)

Once you have completed the lists, please indicate which inputs are associated with which processes by using arrows. Similarly connect each process with its associated product(s) or outputs. An example of this identification process is also provided on the next page. Once completed, this identification page should be pulled out so that the coding system (A, B, C; 1, 2, 3; i, ii etc.) can be easily used in the rest of the questionnaire. Please remember to enclose this sheet when returning the questionnaire.

II. (Continued)

Simplified Example of Input-Output Flow



III. Input, Output and Process Specification

Briefly describe the content of each input, process and output identified. Indicate sources and destinations for inputs and outputs respectively. Also, indicate number of years produced or received.

INPUTS

A._____

_____

Source of Input:_____

_____Years Received:_____

B._____

_____

Source of Input:_____

_____Years Received:_____

C._____

_____

Source of Input:_____

_____Years Received:_____

D._____

_____

Source of Input:_____

_____Years Received:_____

E._____

_____

Source of Input:_____

_____Years Received:_____

F._____

_____

Source of Input:_____

_____Years Received:_____

G._____

_____

Source of Input:_____

_____Years Received:_____

H._____

_____

Source of Input:_____

_____Years Received:_____

I._____

_____

Source of Input:_____

_____Years Received:_____

(Continue on back if necessary)

PROCESSES

i._____

_____

_____Years Performed:_____

ii._____

_____

_____Years Performed:_____

iii._____

_____

_____Years Performed:_____

(Use back of this page for additional processes, if necessary)

OUTPUTS

1._____

_____

Destination:_____

_____Years Produced:_____

2._____

_____

Destination:_____

_____Years Produced:_____

3._____

_____

Destination:_____

_____Years Produced:_____

4._____

_____

Destination:_____

_____Years Produced:_____

5._____

_____

Destination:_____

_____Years Produced:_____

6._____

_____

Destination:_____

_____Years Produced:_____

(Continue below and on back, as necessary)

IV. Classification

In the grid below, indicate which categories apply to the inputs and outputs you have listed. Multiple categorizations, are of course possible. Indicate applicable categories with a check (✓) under appropriate column code.

Is the information in any way	Inputs A	B	C	D	E	F	G	H	I	Outputs 1	2	3	4	5	6
a. a scenario, projection, forecast, or contain "what if" questions or answers?															
b. a review, evaluation, feedback, sanction, concurrence or non-concurrence, reclama?															
c. an identification of variables, factors, or problem elements; or a structure for considering them?															
d. quantitative information, numbers associated with problem elements?															
e. a direction, statement of policy or procedures to be followed?															
f. a specification of available resources or resource constraints?															
g. a documentation of a processing method, technique, approach?															
h. best described by some other category? If so, what? (state category below and make (✓) at right)															

_____

V. Description

As in the last section, check the appropriate column(s) at right for each category at left that applies

		INPUTS									OUTPUTS					
	The information is:	A	B	C	D	E	F	G	H	I	1	2	3	4	5	6
Format	a. Prescribed (formal)?															
	b. Written?															
	c. Routine?															
	d. Request?															
	e. Response?															
Tone	f. A suggestion?															
	g. A recommendation?															
	h. Guidance?															
	i. A directive?															
	j. A command?															
Frequency	k. Reported yearly?															
	l. Reported monthly?															
	m. Reported weekly?															
	n. Reported on request?															
Characteristics	o. Accompanied by substantial informal dialogue?															
	p. WIDELY VARIABLE IN KIND OR QUANTITY (I.E., ± 20% OR MORE) FROM YEAR TO YEAR?															

VI. Resource Utilization

Enter the appropriate number or check in each column for the following questions.

Inputs	A	B	C	D	E	F	G	H	I
a. The approximate accuracy of this information is . . . enter (✓)									
Not accurate									
Accurate some of the time									
Accurate most of the time									
Always accurate									
b. The wait time for this information or action is . . .									
Not satisfactory									
Satisfactory some of the time									
Satisfactory most of the time									
Always satisfactory									

Outputs	1	2	3	4	5	6
c. The appropriate man years spent on each output in a year. Enter number of man years for each of the following as appropriate.						
Officers						
Enlisted						
Civilian professional						
Civilian clerical						
d. If you believe a different distribution of manpower resources would be more effective in producing the outputs, describe the distribution.						
Officers						
Enlisted						
Civilian professional						
Civilian clerical						

VII. Process

A. Are the outputs that you have identified produced over time as part of a cycle (e. g., the POM or some informal cycle)?

	Yes	No	Do Not Know	If Yes, Name of Cycle	Cycle Length If Known
Output #1	____	____	_____	_____	_____
Output #2	____	____	_____	_____	_____
Output #3	____	____	_____	_____	_____
Output #4	____	____	_____	_____	_____
Output #5	____	____	_____	_____	_____
Output #6	____	____	_____	_____	_____

B. For the outputs that are part of cycles, what event or communication in the cycle initiates production or submission of the output(s)? Also indicate these "triggers" (if any) for any outputs that are Not part of a cycle.

Output #1 _____

Output #2 _____

Output #3 _____

Output #4 _____

Output #5 _____

Output #6 _____

VII. Process (Continued)

C. Sponsor: Categorize the output(s) according to the appropriate "sponsor" context. A given output can occur in more than one of these contexts. If you are not familiar with the sponsor context of an output(s), indicate below in item 10.

	Output # (Code)	Name(s) of Mission, Program, etc.
1. Produced as a major mission sponsor requirement	_____	_____
2. Produced as a force/ function sponsor requirement	_____	_____
3. Produced as an appropriation sponsor requirement	_____	_____
4. Produced as a program element sponsor requirement	_____	_____
5. Produced as a Navy wide support sponsor requirement	_____	_____
6. Produced as a Program sponsor requirement	_____	_____
7. Produced as a Military Manpower Claimant sponsor	_____	_____
8. Other (Specify)	_____	_____

9. If any of the outputs are related to OCMM, briefly specify the relationship.

_____

_____

10. Not familiar with sponsor context of the following output(s): (List appropriate outputs by code)

_____

VII. Process (Continued)

D. For each process, specify the problem solving technique used. Well known techniques such as PERT-CPM, linear programming, regression etc., need only be named. Techniques that you cannot label with technical terms should be briefly described.

Process

i.

ii.

iii.

(Continue on back of page if necessary)

VIII. Benefits

In this section you are asked to estimate certain benefits associated with inputs and outputs you have identified. Four types of estimates are requested, potential contribution, received value, utilization value and overall benefit. Definitions and appropriate scales for each are given below. The estimates should be entered in Table VIII according to the input/output codes (A, B, C etc.,/1, 2, 3 etc.). Fill in all input columns first, then go to outputs.

- Potential Contribution (Column 1)

For inputs, this is your estimate (perception) of the contribution the input would make to your output(s) if it were perfect and you were free to make full use of it. For outputs, the meaning is essentially the same except that you are indicating your perception of the potential contribution of your output (given that it is perfect) to satisfying the need(s) of its recipient(s).

Scale:						
	No contribution,	enter	0	in column		1
	Low "	"	1	"	"	1
	Moderate "	"	2	"	"	1
	High "	"	3	"	"	1
	Very high "	"	4	"	"	1

- Received Value (Column 2)

For inputs, this is your estimate of the value of the input as you usually receive it, assuming you are free to use all that you receive. Express this "received value" as a percent of the "potential contribution" indicated in column 1. For outputs, "received value" is your estimate of the percent of the outputs "potential contribution" normally delivered to its consumer(s).

Scale: 0 - 100% in column 2

- Utilization Value (Column 3)

For inputs, this is the proportion of "received value" (column 2) that you are normally able to use, considering limits imposed by time constraints, available resources for utilizing information received, etc. For outputs, "Utilization Value" is your perception of the proportion of "received value" ultimately used by consumers.

Scale: 0 - 100%

- Overall Benefit (Column 4)

For both inputs and outputs, this is your perception of their benefit to manpower/personnel management in general (considering everything you feel to be relevant).

Scale:						
	No benefit	enter	0	in column	4
	Low	"	"	1	"	"	4
	Moderate	"	"	2	"	"	4
	High	"	"	3	"	"	4
	Very high	"	"	4	"	"	4

- Other Uses (Column 5)

Indicate in this column whether to your knowledge, the given input or output is normally used for purposes other than those related to manpower/personnel planning.

Scale: Yes or No

- Feedback (column 6)

For inputs, indicate whether you normally provide feedback to their sources on your perceptions of the input's value. For outputs, indicate whether your perceptions are based on feedback from consumer(s).

Scale:						
	No feedback	enter	0	in column	6
	Feedback sometimes	"	1	"	"	6
	Feedback most times	"	2	"	"	6
	Feedback all the time	"	3	"	"	6

Table VIII Benefits

INPUTS Code	Potential Contribution 1	Received Value 2	Utilization Value 3	Overall Benefit 4	Other Uses 5	Feedback 6
A.						
B.						
C.						
D.						
E.						
F.						
G.						

OUTPUTS Code						
1.						
2.						
3.						
4.						
5.						
6.						

IX. Comments and Recommendations

The three questions below ask for your comments and recommendations concerning the requirement, production and flow of manpower/personnel information. We would appreciate any views that you might have about these areas. (Use back of page where necessary).

A. Are there any data or other inputs not being presently received that would significantly contribute to your effectiveness in the manpower/personnel area? If so,

(1) briefly describe the additional input(s)

_____

_____

_____

(2) state how the additional input(s) would be used

_____

_____

_____

(3) who would be the probable source of the input(s)?

_____

_____

_____

B. Similarly, if there is valuable manpower/personnel information that you could additionally produce, please indicate

(1) The nature and probable use of this information

_____

_____

_____

IX. Comments and Recommendations (Continued)

(2) Is the necessary data presently available? If so, from what source?

(3) Would significant additions to your present resources (i. e., staff, equipment etc.) be required to produce this information?

C. Please indicate any other thoughts you have concerning possible improvements to the present flow of manpower/personnel information.